MINERALOGICAL NOTES: No. VII.—RHODONITE, BROKEN HILL, NEW SOUTH WALES.

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(Plates xxviii-xxix.).

Fine specimens of rhodonite are found in the sulphide zone of the Broken Hill silver-lead mines, associated with galena, blende and garnet. The occurence seems to have been first noted by Professor R. Beck of Freiberg, by whom it has been described.[1] It is found either as crystals with the characteristic rounded edges of rhodonite, or as isolated fragments disseminated through the ore; it generally shows evidence of corrosion by the metalliferous solutions, and various stages of replacement by galena and blende may be traced. The mineral is of a pleasing deep red colour, and in small well crystallised specimens is quite transparent; it greatly resembles some varieties of garnet.

Of the seven specimens which form the subject matter of this paper three were kindly lent by the Director of the National Museum, Melbourne, one by the Geological Department of Sydney University, the others are from the Australian Museum collection.

Five crystals (referred to hereafter as Nos. i.-v.) were measured on the two-circle goniometer and the co-ordinate angles obtained; a few interfacial angles were also determined The position chosen is that of Goldschmidt,[2] which, for rhodonite considered by itself, and particularly for the usual habit of the Broken Hill crystals, is more suitable than Dana's,[3] as the three most prominent faces, which are also the directions of cleavage, are made axial planes, but Dana's elements show more clearly the relation of rhodonite to the other members of the pyroxene group.

In habit the crystals vary somewhat, but they may be generally described as extended parallel to *c* (010). The commonest forms are *a* (001), *c* (010), *b* (100), *o* (110), *s* (1$\bar{1}$0), the three first being particularly well developed. In all twenty-eight forms were recognised, of which ten are new, or at least not recorded in Goldschmidt's 'Winkeltabellen.' The new faces occur principally

[1] Beck—Zeits. prakt. Geol., March, 1899, pp. 65-71 (*trans.* Rec. Geol. Surv. N.S. Wales, vii., 1, 1900, pp. 20-28).

[2] Goldschmidt—Krystallographische Winkeltabellen, p. 287.

[3] Dana—System of Mineralogy, 6th Edition, 1892, p. 378.

in the zones [010, 001] and [100, 001], and are, as a rule, long and very narrow, giving only fair reflections, hence some of them may be merely vicinal in character; the face $(\bar{1}\bar{1}3)$ is dull, and the reflection was obtained by cementing a fragment of glass on it; $(\bar{1}\bar{1}2)$ appears as a small square patch. On crystal iv. there is a dull rounded face, probably $(\bar{1}\bar{1}\bar{2})$, but it did not admit of even approximate measurement. The faces (207) and $(0\bar{3}7)$ may be vicinal to (103) and $(0\bar{1}2)$ respectively, the others are undoubtedly valid forms. The available information regarding the new forms is tabulated below; two readings enclosed by brackets are independent determinations made on the same plane. Crystals i., iii., iv. are from the collection of the National Museum, Melbourne; ii from the Sydney University collection.

Form.	Cryst.	Measured.		Calculated.		Reflection.
		ϕ	ρ	ϕ	ρ	
		° ′	° ′	° ′	° ′	
A 013	i.	30 30	38 16			fair +
		30 35	38 0	30 11	38 10	
B $0\bar{1}5$	ii.	127 20	26 27	127 21	26 26	fair
C $0\bar{1}4$	i.	134 8	29 0			fair +
		134 17	29 2			
	iii.	134 44	29 18			fair +
	iv.	134 47	29 8	134 53	29 9	good
D $0\bar{1}3$	i.	144 28	34 3			fair
		144 15	33 58			
	ii.	143 39	33 37			fair +
	iv.	143 34	34 9	144 9	34 1	poor
E $0\bar{3}7$	i.	151 19	39 24			fair
		151 19	39 31	151 19	39 28	
F 103	ii.	87 32	44 8	87 33	44 1	good
G 207	ii.	86 51	40 58			fair +
	v.	88 41	39 38	87 6	41 33	fair
H $\bar{2}01$	iii.	$8\bar{7}$ ·3	71 45			poor
	iii.	$\overline{86}$ 6	71 41			fair
		86 2	71 54	$\overline{85}$ 56	71 51	
K $\bar{1}\bar{1}3$	iv.	$\overline{161}$ 24	29 30	$\overline{161}$ 32	29 9	
L $\bar{1}\bar{1}2$	iii.	150 16	43 9			good
		150 13	43 15	150 27	43 10	

The elements were calculated from the following angles, all the reflections being sharp :—

Form.	Mean.		Limits.		No. of Measurements.
	ϕ	ρ	ϕ	ρ	
	° ′	° ′	° ′ ° ′	° ′ ° ′	
o 110	44 11½	— —	44 5 to 44 19	— — — —	14
b 100	92 30		92 27 „ 92 41	— — — —	16
a 001	80 30	21 50½	80 22 „ 80 44	21 48 to 21 52	13
p 102	88 41	51 25	88 37 „ 88 45	51 23 „ 51 30	4

The elements deduced are compared below with those given by Goldschmidt in his Winkeltabellen :—

	a	β	γ	*a*	*c*
	° ′	° ′	° ′		
Anderson ..	94 46	111 34	85 56	1·14792	1·83158
Goldschmidt.	94 42	111 27	86 06	1·1550	1·8317

The elements for Dana's position were also calculated for comparison with Flink's[4] as corrected by Dana, and Pirsson's for the fowlerite variety[5] :—

	a	β	γ	*a*	*c*
	° ′	° ′	° ′		
Anderson ..	103 21	108 42	82 6	1·07281	·62379
Flink	103 18	108 44	81 39	1·07285	·62127
Pirsson ..	103 39	108 48½	81 55	1·078	·62627

Comparison of these elements suggests a morphotropic relationship, and it is very desirable that the exact composition of Broken Hill rhodonite should be ascertained; at present, however, a sufficient quantity of suitable material is not available.

A brief description of the individual specimens follows (lettering according to Goldschmidt).

[4] Flink—Zeits. Kryst., xi., 1886, p. 506.
[5] Pirsson—Amer. Journ. Sci., xl., 1890, p. 484.

Crystal i. (Plate xxviii., figs. 1, 2).—This is the smallest and the best crystal; it measures 1 × ·2 × ·5 cm. in the axial directions, is practically free from gangue, and quite transparent. In habit it is elongated parallel to the *a* axis, and might almost be described as tabular on (010).

Combination :—*a c b o s π A C D E m k i q p u r l n.*

Crystal ii. (Plate xxviii., figs. 3, 4).—It is the front half of a crystal, incomplete below, measuring 1·6 × 1·1 × 1·5 cm., and carries a good deal of attached galena as cleavage fragments and small grains. The faces *o* (110) and *k* ($0\bar{1}1$) are unusually large.

Combination :—*a c b o s κ B D m k i p F G μ.*

Crystal iii. (Plate xxix., figs. 1, 2).—This crystal measures 1·1 × ·8 × 1·2 cm., and may be described as thick tabular on (010); on 100 there is a rounded depression like a small thumb mark; the left side of the figure is bounded mainly by a cleavage plane. Galena in cleaved lumps is attached to the lower surface.

Combination :—*a c b o s κ π C k r l n H L φ.*

Crystal iv. (Plate xxix., fig. 3).—The crystal is broken in front and below; size 1·8 × 1 × 1 cm. It seems to consist of two sub-individuals not quite in parallel position with galena intruding between.

Combination :—*a c b o C m k u r l k L*(?).

Crystal v.—This is the largest measured crystal, 2·2 × 1·1 × 1·3 cm., but it carries much galena.

Combination :—*a c b o k p G μ.*

Of the remaining specimens one consists of several crystals, large and small, accompanied by galena; one broken crystal measures about 5 × 3 × 2·5 cm.; this specimen and crystal v. are from the Block 10 mine. The other is similar, but the crystals of rhodonite and galena are all small, forming a sort of mosaic.

The mean angles are tabulated below along with the theoretical values deduced from the calculated elements; the lettering according to Goldschmidt and Dana, with the corresponding Miller indices, are given side by side; new forms are distinguished by an asterisk.

The equations for transforming *h k l* of Goldschmidt to *h′ k′ l′* of Dana are, $h' = -(h+k)$, $k' = -(h-k)$, $l' = -\frac{1}{2}l$; thus any face P, *h k l*, becomes P′, $\bar{h}'\,\bar{k}'\,\bar{l}'$.

Forms.				Measured.				Calculated.			
Goldschmidt.		Dana.		ϕ		ρ		ϕ		ρ	
				°	′	°	′	°	′	°	′
a	001	c	001	80	30	21	50½	80	30	21	50
c	010	M	$1\bar{1}0$	0	0	90	0	0	0	90	0
b	100	m	110	92	30	89	59	92	30	90	0
o	110	a	100	44	11½	89	59½	44	11½	90	0
s	$1\bar{1}0$	b	010	138	10	89	59	138	8	90	0
κ	011	κ	$2\bar{2}1$	12	9	63	15	11	43	62	48
π	012	π	$1\bar{1}1$	21	50	46	48	21	50	46	44
*A	013	A	$2\bar{2}3$	30	32	38	8	30	11	38	10
*B	$0\bar{1}5$	B	$\bar{2}25$	127	20	26	27	127	21	26	26
*C	$0\bar{1}4$	C	112	134	33	29	7	134	53	29	9
*D	$0\bar{1}3$	D	223	144	0	33	49	144	9	34	1
*E	$0\bar{3}7$	E	667	151	19	39	28	151	19	39	28
m	$0\bar{1}2$	m	$\bar{1}11$	155	10	43	16	155	9	43	15
k	$0\bar{1}1$	k	$\bar{2}21$	167	32	61	15	167	26	61	21
i	$0\bar{2}1$	i	$\bar{4}41$	173	48	74	39	173	45	74	36
q	101	q	$2\bar{2}1$	90	14	64	20	90	14	64	37
p	102	p	111	88	41	51	25	88	41	51	25
*F	103	F	223	87	32	44	8	87	33	44	1
*G	207	G	447	87	28	40	31	87	6	41	33
u	$\bar{1}03$	u	$\bar{2}23$	$\bar{6}3$	10	11	14	$\bar{6}2$	42	11	15
r	$\bar{1}02$	r	$\bar{1}\bar{1}1$	$\bar{7}7$	31	25	17	$\bar{7}7$	22	25	22
l	$\bar{2}03$	l	$\bar{4}\bar{4}3$	$\bar{8}1$	3	37	13	$\bar{8}1$	11	37	10
n	$\bar{1}01$	n	$\bar{2}\bar{2}1$	$\bar{8}3$	47	53	9	$\bar{8}3$	54	53	1
*H	$\bar{2}01$	H	$\bar{4}\bar{4}1$	$\bar{8}6$	4	71	47	$\bar{8}5$	56	71	51
μ	111	μ	401	48	59	70	18	49	4	70	19
*K	$\bar{1}\bar{1}3$	K	$\bar{4}03$	$\bar{1}6\bar{1}$	24	29	30	$\bar{1}6\bar{1}$	32	29	9
*L	$\bar{1}\bar{1}2$	L	$\bar{2}01$	$\bar{1}5\bar{0}$	14	43	12	$\bar{1}5\bar{0}$	27	43	10
ϕ	$\bar{1}\bar{1}1$	ϕ	$\bar{4}01$	$\bar{1}4\bar{2}$	2	65	6	$\bar{1}4\bar{2}$	8	65	4

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